It is probable that this reaction would produce the naphthalamine term, corresponding to anilocyanic and cyanic acid.

Cyanic acid..............	C_2 H NO_2
Anilocyanic acid...........	$C_{14} H_6 NO_2$
Naphthocyanic acid	$C_{22} H_8 NO_2$

Menaphthoximide, when heated, yields, in fact, a vapour of a most penetrating organic odour; but Mr. Perkin has not yet obtained sufficient material for a more minute examination of the body to which it belongs.

January 24, 1856.

Sir BENJAMIN BRODIE, Bart., V.P., in the Chair.

A paper was in part read, entitled "Account of Pendulum Experiments undertaken in the Harton Colliery for the purpose of determining the Mean Density of the Earth." By G. B. AIRY, Esq., Astronomer Royal. Received December 26, 1855.

January 31, 1856.

The LORD WROTTESLEY, President, in the Chair.

The reading of Mr. AIRY's paper, entitled "Account of Pendulum Experiments undertaken in the Harton Colliery for the purpose of determining the Mean Density of the Earth," was resumed and concluded.

(Abstract.)

In the first section of this paper, the author explains the reasons, founded on calculation, which appeared to make it probable that the comparison of gravity at the top and the bottom of a mine

would give means of determining the earth's mean density with accuracy, perhaps superior to that obtained in the Schehallien or the Cavendish experiment; and which induced him first in the summer of 1826 (in concert with Dr. Whewell), and again in 1828 (with Dr. Whewell, Mr. Sheepshanks and others), to try the experiment in the Dolcoath mine near Camborne in Cornwall. These attempts were both frustrated by accidents having no connexion with the essential parts of the experiment. After a lapse of many years, he found that several circumstances (of which one was the general familiarity with the manipulation of the galvanic telegraph and the facility of applying it to the comparison of widely separated clocks) were very favourable to a repetition of the experiment; and having selected the Harton Colliery in the neighbourhood of South Shields as a fit place, in which two stations could be found in exactly the same vertical but at 1256 feet difference of height, and being assured of every assistance from the owners of the mine, he proceeded with the experiments in the months of September and October 1854.

The principal instruments employed were two detached pendulums on iron stands, the property of the Royal Society, which were most carefully repaired by Mr. Simms; graduated arcs, barometers, thermometers, &c.; two clocks, one the property of the Royal Society, which were fitted for this purpose with inclined gilded reflectors upon the pendulum bobs, intended to be illuminated by the light of lamps passing through holes in the side of the clock-cases; galvanometer-needles attached to the clock-cases, with circuit-breakers; a galvanic battery at the upper station; a journeyman-clock at the upper station, fitted with an apparatus by which it completed the galvanic circuit at every 15^s of its own time; and two galvanic wires passing down the mine-shaft and forming a closed circuit through the battery, the journeyman-clock, and the two galvanometers.

The working party consisted of Mr. Dunkin (superintendent) and Mr. Ellis from the Royal Observatory, Mr. Pogson from the Observatory of Oxford, Mr. Creswick from the Observatory of Cambridge, Mr. G. Rümker from the Observatory of Durham, and Mr. Simmonds from Mr. Carrington's Red Hill Observatory.

The plan of operations was this. Simultaneous observations of the two pendulums (one in the upper and the other in the lower

station) were kept up *incessantly* during the whole working time (day and night) of one week; then the pendulums were interchanged and were observed in the same manner through another week; after this the pendulums were twice interchanged, but the two last series of observations were so much shortened that both were included in one week. Each pendulum had six swings of nearly four hours each, on every day of observation; and between the end of one swing and the beginning of the next, numerous galvanic signals were passed for the comparison of the clocks.

The second section gives the details (as far as space permits) of the comparisons of clocks by the galvanic signals. On examining the proportion of rates, it was found that there was distinctly a personal equation in the observation of the galvanic signals. Approximate values for the different observers were obtained, and the proportion of rates was corrected (where necessary) for these equations.

The third section describes the general system of observing the pendulums and reducing the observations. For ascertaining the time of a coincidence of the vibration of the detached pendulum with that of the clock pendulum, the mean of the times of the first disappearance and the last re-appearance was employed. Several coincidences were observed at the beginning of a swing and the mean was taken: and several were observed, and the mean taken, at the end of the swing. From these means, a mean interval of coincidences was obtained; from which the ratio of the actual rate of the detached pendulum to that of the clock pendulum was found. This requires several corrections.

The correction depending on the arc of vibration, with no data except the first and last arcs of vibration, and no assumption of a mathematical law for the intermediate arcs, is made to depend on the results of experimental observations on the numerical decrease of the arc by a peculiar process.

The corrections depending on the temperature and the atmospheric pressure are based mainly on Sabine's experiments.

The fourth section contains an abstract of the Pendulum Observations at the Upper Station, with the corrected logarithm of the rate of the detached pendulum on the clock pendulum for every swing; and the fifth section contains a similar abstract for the Lower Station.

The sixth section gives the computation of the logarithm of the rate of the lower detached pendulum upon the upper detached pendulum (for which the preceding sections have furnished the elements). Then is given in detail the investigation, by the Theory of Probabilities, of the formula for the best combination of the results of the different swings. The advantage of the method of incessant observations with numerous comparisons of the clocks is pointed out. The formula is applied to the four series of observations; and the results of the first and third series agree very closely, and those of the second and fourth series agree very closely, showing that the pendulums had undergone no sensible change. By comparing the mean of the first and third series with the mean of the second and fourth, the proportion of pendulum rates at the upper and lower stations is obtained independently of the pendulums employed. The conclusion is that gravity below is greater than gravity above by $\frac{1}{19286}$th part, with an uncertainty of $\frac{1}{270}$th part of the excess; or that the acceleration of a seconds' pendulum below is $2^{s}{\cdot}24$ per day, with an uncertainty of less than $0^{s}{\cdot}01$. Reasons however are given for believing that the uncertainty is greater than this quantity.

The seventh section contains a description of the operation for measuring the depth of the mine. It then treats of the process to be employed for computing the proportion of gravity at the upper and lower stations (without reference to the experiments), on an assumed proportion of the density of the mine-rocks to the earth's mean density. It is shown that, supposing the upper surface of the ground about Harton to have the true spheroidal form, it is unnecessary to give any attention to the irregularities of the surface on distant parts of the earth. It is also shown that there is no reason to doubt the correctness of the law of decrease of the attraction of the earth's nucleus as depending on the elevation of the station, unless there be some serious irregularity in the arrangement or density of the matter immediately below Harton. Assuming this to be insensible, the theory of correction for the inequalities of ground in the neighbourhood of Harton is then considered. The elevation of the upper station is about 74 feet above high water; and as it appears from this that the depth of inequality can in no case amount to one-tenth of the depth of the lower station, it is easily found that

the excess or defect of attraction will be computed with sufficient accuracy by supposing the excess or defect of matter to exist absolutely at the surface; in which case the effect on the upper station is nothing, and that on the lower station is easily computed. For depressions like that of the sea bounded (at least for the purposes of computation) by a straight line near the mine, but unlimited in the other direction, a simple formula is found.

For the application of these theorems it was necessary to have a map giving the elevations of the ground at various points. By instruction of the Mayor and Corporation of South Shields, the Corporation Surveyor, Christopher Thompson, Esq., prepared such a map. In the use of it, it was found convenient to adopt as unit of linear measure the depth of the mine. A line at the distance of ten depths very nearly touches the cliffs of Tynemouth, of Frenchman's Point, and of some points further to the south-east. The land generally is divided into squares whose sides are one depth each, and these are grouped as appears convenient for representing approximately the form of the ground by compartments each of a uniform elevation through its extent. The principal requirements are, besides taking account of the depression of the sea beyond the ten-depth line, to estimate the effect of the curvature of the coast towards the mouth of the Wear, to compute the effect of the hollow of Jarrow Slake, and generally to make proper allowance for the absence of matter in the valley of the Tyne. There are also some small elevations to be considered. The general result is, that the attraction of the regular shell of matter is to be diminished by about $\frac{1}{280}$th part.

Putting D for the mean density of the earth, d for that of the shell, the fraction $\frac{\text{Gravity below}}{\text{Gravity above}}$ is computed to be $1{\cdot}00012032 - 0{\cdot}00017984 \times \frac{d}{D}$. The pendulum experiments give $1{\cdot}00005185$. The comparison of these gives $\frac{D}{d} = 2{\cdot}6266$.

The eighth section contains a detailed account of the strata passed through in sinking the Harton shaft, and the specific gravities of many of the beds as determined by Professor W. H. Miller. The result for the mean specific gravity is 2·50. Substituting this in the

equation given by the pendulum experiments, the mean specific gravity of the earth is found to be 6·566. Adverting to the excess of this number above those given by the Schehallien and the Torsion-rod experiments, the author remarks that it is very difficult to assign the causes or the measures of error in either of the experiments, but expresses his belief that the result of the present experiment may compete on at least equal terms with the others.

A paper was also read, entitled "A Description of a new Sphygmoscope, an Instrument for indicating the Movements of the Heart and Blood-vessels; with an Account of Observations obtained by the aid of that Instrument." By S. Scott Alison, M.D., Licentiate of the Royal College of Physicians, London. Communicated by G. O. Rees, M.D., F.R.S. Received January 12, 1856.

The sphygmoscope (fig. 1) consists of a small chamber containing spirits of wine or other liquid, provided with a thin india-rubber wall, where it is to be applied to the chest. At the opposite extremity the chamber communicates with a glass tube, which rises to some height above the level of the chamber. Liquid is supplied to the instrument until it stands in the tube a little above the level of the chamber. The pressure of the column of liquid in the tube acts upon the elastic or yielding wall of india-rubber and causes it to protrude. This protruding part or chest-piece is very readily affected by external impulse; it yields to the slightest touch, and being pushed inwards, causes a displacement of the liquid in the non-elastic chamber, and forces a portion of liquid up the tube. The protruding wall of india-rubber is driven inwards when it is brought in contact with that portion of the chest which is struck by the apex of the heart, and a rise in the tube takes place. When the heart retires, the india-rubber wall, affected by the pressure of the column of liquid in the tube, is pressed back, follows the chest, and permits the liquid to descend. The degree to which the india-rubber wall is forced in by the apex of the heart is denoted by a corresponding rise in the tube, and the amount of protrusion of the india-rubber